FOREST PEST MANAGEMENT
Pacific Southwest Region

FPM Report No. C96-7 36.70272 -118.93754 3420

August 15, 1996

ARMILLARIA ROOT DISEASE IN A GIANT SEQUOIA PLANTATION ON THE HUME LAKE RANGER DISTRICT, SEQUOIA NATIONAL FOREST

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BACKGROUND

In June of 1995, personnel from the Sequoia National Forest Supervisor's Office and the Hume Lake Ranger District noticed several dying giant sequoia saplings in a plantation just below the boundary of Whitaker Forest (property of the University of California). I visited the site in August and October of 1995 and most recently on July 16, 1996, accompanied by Lew Jump (SO), Larry Burd (Hume Lake RD), and John Wenz (Shared Service Area entomologist). This report summarizes what has been observed at the site.

The Whitaker plantation covers 12 acres and resulted from a timber sale logged in 1983, which removed all tree species except giant sequoia. After broadcast burning in 1985, the site was planted in 1986 with 1-0 giant sequoia at a rate of 345 trees/acre. Elevation of the plantation is 5200 feet and site class is a Dunning II.

By August, 1995, one 49" DBH overstory sequoia plus about a dozen seedlings/saplings were dead. The overstory tree was still green and alive, but declining, in June of 1995. Two viable conks of Heterobasidion annosum (annosus root disease) were found withing the vicinity of killed trees; one in a white fir stump and one in an incense-cedar stump. In addition, mycelial mats of Armillaria sp. (Armillaria root disease) were present at the root crown of all recently killed trees, including the 49" DBH giant sequoia. Two black oak stumps were present within the pocket of conifer mortality.

In October of 1995, all dead trees were located, tagged, mapped and examined. The year of death was estimated and specimens of Armillaria were collected. Mushrooms of Armillaria were beginning to form at the base of several recently killed sapling sequoias and the large overstory sequoia. By the end of the 1995 season, 14 giant sequoia and 1 incense-cedar had been killed in an area roughly 120 feet by 120 feet. All trees had been girdled by Armillaria. Five of these died in 1995, 8 in 1994, and 2 prior to 1994.

Cultures from 7 dead trees were sent to a Forest Pest Mangement laboratory in Rapid City, South Dakota (R-2) that is equipped to determine species of Armillaria. Results showed that all cultures were one clone of Armillaria mellea, the most common species of this genus in California. In culture, this clone of Armillaria was very aggressive and outgrew the reference (tester) isolates, suggesting that it may also be unusually aggresive in field situations.

There were no additional dead trees in the original mortality pocket when the site was last visited on July 16, 1996. One sequoia sapling (4" DBH and 13' tall), however, was found on the opposite side (west) of the plantation. It had faded this summer and was 15' from an old California black oak stump.

DISCUSSION/CONCLUSIONS

The evidence gathered at Whitaker plantation points to Armillaria mellea being the primary cause of giant sequoia mortality. Annosus root disease signs are present on the site, but its role remains questionable or unclear. Armillaria root disease in California most often involves the death of planted conifers on sites where black oak was removed. Mortality occurs within 5 - 15 years following oak removal and conifer planting. The events in this plantation fit the normal scenario of Armillaria root disease. What is unusual is there are very few oak stumps in Whitaker plantation. Those present were well decayed with heart rot prior to cutting and did not give the appearance of providing a good food base for Armillaria. Abundant soil moisture may have favored root disease, but I would not have considered this site as one with a high probability for Armillaria root disease.

Mortality should be restricted to sequoia growing within the root zone of black oaks. Planted sequoia are not large enough to continue spreading root disease throughout the plantation. The one large overstory sequoia, however, may serve as a reservoir and food base for Armillaria. Additional sapling mortality may occur in the vicinity of this tree, although conifer to conifer spread of A. mellea is not common.

It is very difficult to control this root disease once it is established and killing trees. Prevention is a better solution, but we cannot accurately predict when and where Armillaria will become a problem. It is a very common fungus, but does not always cause tree mortality. There is considerable brush competition in much of the plantation. Keeping conifers healthy and vigorous by minimizing competition could help reduce the negative impact of root disease. Allowing black oaks to remain alive is probably the best action to avoid future problems from Armillaria.

ARMILLARIA ROOT DISEASE - BIOLOGY

Fungi in the genus Armillaria are widely distributed in soils and usually live as saprophytes on dead wood or other organic matter. Until about 1980, it was thought that only the species Armillaria mellea existed in North America. Recent research, however, has shown that nine species may be present. In California, A. mellea is the most common species, followed by A. gallica. The following discussion refers to A. mellea.

This fungus has a wide host range, including virtually all woody plants in California. It is frequently associated with hardwood roots, especially oaks. Healthy oaks are resistant to the fungus. This resistance disappears, however, when trees are weakened, stressed, cut, or killed, and Armillaria may then rapidly colonize and decompose roots and sometimes entire root systems. Stresses that have been linked to increased damage from this root disease include insect defoliation, drought, excessive soil moisture, poor planting techniques, bark beetle attack, air pollution injury, and nutrient deficiencies.

The organic material used as a source of nutrition is called a food base. With a large food base to utilize, the fungus becomes more aggressive and moves to the roots of nearby trees by means of root contacts and rhizomorphs. Rhizomorphs are structures that resemble black shoestrings and grow like roots through upper soil layers. The predominant method of tree to tree spread in California is via root contact; rhizomorphs are more important and prevalent in other areas of the country.

Armillaria is capable of directly penetrating through the intact root bark of living trees, and once it reaches the cambium it usually grows rapidly, producing a flat, white, leathery, fan-shaped mycelial mat. Rhizomorphs are often associated with the mat. If the fungus reaches the root collar it girdles the stem and kills the tree. After Armillaria successfully colonizes a root segment or root system, it continues to decay the wood and causes a white to yellowish, wet, stringy rot. This rot does not usually extend up the stem more than a few feet above the soil line.

Clusters of mushrooms may be found in the fall at the base of infected dead or dying trees and stumps. These mushrooms may also grow directly out of the soil near the food base. Spores produced by fruiting bodies are not an important source of new infections or long distance spread.